# NEW THINKING AND

# AMERICAN DEFENSE TECHNOLOGY



Second Edition MAY 1993



A Report of the

CARNEGIE COMMISSION
ON SCIENCE, TECHNOLOGY, AND GOVERNMENT

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Accession Number: 4506

Publication Date: May 01, 1993

Title: New Thinking and American Defense Technology: A Report of the Carnegie Commission on Science, Technology, and Government

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Corporate Author Or Publisher: Carnegie Commission on Science, Tech., & Govt., 10 Waverly Pl., NY, NY

Comments on Document: This second edition includes as Chapter 7, a statement on reform of the defense procurement system that was approved by the Commission in December 1992. First edition was adopted May 1, 1990.

Descriptors, Keywords: US Defense Technology Carnegie Commission Perry Carter Science Government Industry Dual Use Transfer

Pages: 00046

Cataloged Date: May 28, 1993

Document Type: HC

Number of Copies In Library: 000001

Record ID: 26874

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# FOREWORD TO THE SECOND EDITION

*New Thinking and American Defense Technology* was first published in 1990. The recommendations made in the first edition are still valid, and the changes in the Soviet Union, together with the results of Desert Storm and the large expected decline in the defense budget, make procurement reform even more urgent. Because of this urgency, this new edition includes as Chapter 7 a statement on reform of the defense procurement system that was approved by the Commission in December 1992.

The new statement points out that

- The overhead costs of the current acquisition system are some $50 billion per year and, if the system is not changed, they will account for an increasing percentage of a declining defense budget.
- Weapons development and procurement procedures are incompatible with commercial practice, preventing the mutual reinforcement that is critical to the health of both the civilian and defense industrial base.

- Inertia in the present system makes it impossible to create and mobilize the U.S. defense force of the future–smaller, cheaper, and more flexible but still unmatched by any potential opponent.

The sweeping reform that the statement recommends calls for complete replacement of the existing system by a system patterned on commercial practice, not merely making incremental adjustments. The result will be a restructured defense industrial base capable of meeting DoD's peacetime and crisis needs while supporting the technological and industrial competitiveness of the United States.

The new statement draws on earlier work by the Commission's Task Force on National Security, chaired by William J. Perry. The membership of the task force that contributed to the statement differed slightly from the group responsible for preparing the first edition. The members of the enlarged task force were

William J. Perry* (Chair)
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Lewis M. Branscomb
Harold Brown
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The Commission is grateful to Dr. Perry, to the task force members, and to David Z. Beckler, Associate Director of the Commission, who provided staff support.

William T. Golden, Co-Chair
Joshua Lederberg, Co-Chair

* The statement was prepared and approved before the nomination of Dr. Perry to be U.S. Deputy Secretary of Defense and Mr. Woolsey to be Director of Central Intelligence.

# FOREWORD TO THE FIRST EDITION

This report of the Carnegie Commission on Science, Technology, and Government was prepared by Ashton B. Carter, a member of its Advisory Council, and Commissioner William J. Perry. It is based on discussions of an *ad hoc* Task Force on National Security composed of Commissioners and Advisory Council members. The report is endorsed by the Task Force, whose members were

William J. Perry, Chair
Norman R. Augustine
Lewis M. Branscomb
Harold Brown
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The report was adopted by the Carnegie Commission at its meeting on May 1, 1990. The Commission is grateful to Dr. Perry and Dr. Carter, to the Task Force members, and to David Z. Beckler, Associate Director of the Commission, who provided staff support.

Joshua Lederberg, Co-Chair
William T. Golden, Co-Chair

# INTRODUCTION

The national security of the United States is and will remain heavily dependent on the wise application of the nation's impressive scientific and technological capability. But political, economic, and technological changes are occurring in the world that call for creative adaptation by government if it is to continue to make effective use of science and technology for the nation's security:

- The momentous political changes in the Soviet Union and Eastern Europe in the wake of "new thinking" in the Soviet Union are replacing the monolithic Eastern bloc military threat, to which American defense technology has been directed for almost half a century, with a more complex, variegated, and uncertain threat. Technology will be one of the nation's chief hedges against the uncertainties of the future.
- At the same time, American dominance of virtually all fields of technology—and especially defense technology—during the postwar period

is giving way to a position of first among equals. The Department of Defense consequently must learn how to share in technological advance wherever it takes place, whether in the nondefense sector or in other countries.

- Finally, the Department of Defense has increasing difficulty in selecting, procuring, and managing the technology upon which it depends.

This Task Force report makes recommendations about how the U.S. national security establishment can adapt to these changes with its own "new thinking." In accordance with the charge of the Carnegie Commission on Science, Technology, and Government, these recommendations focus on government organization and decision-making processes, rather than on particular policies or programs.

In past periods of rapid and fundamental change in the national security landscape, the United States has made far-reaching adaptations in its national security establishment and in its links to science and technology. In the wake of World War II, for example, the federal government decided to continue into peacetime many of the innovative mechanisms established during the war for Defense Department support of science and technology, and for the department's exploitation of the newest technological advances. Likewise, after the 1957 launch of the Soviet Sputnik, the government established a host of new agencies and advisory bodies to help it apply technology to defense needs, including strengthening the presidential science advisory mechanism, establishing the Director of Defense Research and Engineering, the Defense Advanced Research Projects Agency, and the National Aeronautics and Space Administration.

Today's challenges for American defense technology are also fundamental and require bold and creative adaptation. The Task Force did not address directly the new policies and programs to meet these challenges, although a readjustment of America's outlook on its national security is surely needed. The Task Force instead focused on identifying adaptations in government organization and decision-making processes that would help fundamental readjustment to occur. None of the adaptations recommended in this report involve the creation of new government agencies, but taken together they can ensure that government is equipped to reflect the "new thinking" that political, technological, and economic change requires of American defense policy.

# I

# THE NEED FOR "NEW THINKING"

## CHANGES IN THE MILITARY THREAT

A discontinuity has occurred in world affairs, with profound consequences for American defense policy. Since an effective defense rests in substantial measure on the application of technology, these changes in the world imply changes for defense technology. But the effect of the changes will be to enhance rather than to diminish the importance of technology in national security.

Under President Mikhail Gorbachev, the Soviet Union has embarked on a dramatically new security policy, which the Soviets call "New Thinking." This policy has countenanced the emergence of noncommunist governments in most of Eastern Europe, putting a *de facto* end to the significance of the Warsaw Pact as a military organization. The Soviet Union has also unilaterally reduced its military forces in Eastern Europe and signed agreements with several new Eastern European governments calling for further

withdrawals. At the same time, pending arms control agreements on conventional and nuclear forces, if carried to completion, would greatly reduce the military threat to the United States and its allies.

These developments have led the Secretary of Defense to conclude that the military threat to the United States has lessened, and has led the North Atlantic Treaty Organization (NATO) to estimate that the Warsaw Pact no longer has a capability for short-warning attack. The U.S. defense budget has decreased each of the last four years, with the expectation of further decreases in the near future in pace with the decreased threat. This trend will continue for the indefinite future if the Soviet Union sustains its "new thinking" in foreign policy and if the Eastern European countries sustain their move toward noncommunist governments independent of the Soviet Union. In that case, the decrease in U.S. defense spending can be commensurate with the decrease in defense requirements.

However, the United States will still need to maintain a readiness to reconstitute its present defense capabilities if there is a reversal in this volatile and still evolving situation. Moreover, while the confrontation between NATO and the Warsaw Pact is easing, the potential for military conflict in the rest of the world is increasing, along with the levels of destruction that would result from such conflicts (witness the devastation that occurred in the high-tech war between Iran and Iraq). And both the United States and the Soviet Union are increasingly unable to exert a moderating influence in regional conflicts (again witness Iran and Iraq). Looking further into the future, one cannot discount the rise of other major economic and military powers hostile to the United States. Thus our military requirements in the future, while considerably different from and less threatening than the cold war of the last four decades, will still be demanding.

The response to these new requirements cannot be simply a fine-tuning of the strategy and forces developed to respond to the superpower confrontation. The United States can get by with a considerably smaller force structure, but the forces will need to have high mobility, and a select portion of them will need to be maintained at high readiness to deal with military contingencies worldwide. Besides this readiness to meet fast-breaking military contingencies, the United States will also need to be prepared to reconstitute its present defense capabilities if the political situation in Europe changes sharply for the worse. This kind of readiness will require a "reserve" defense capability. The concept of reserve forces is well understood with regard to military personnel; it can also be extended to a "reserve technology" capability. The defense technology reserve consists of the knowledge base and the tools to respond quickly when new military needs arise. Thus, the defense technology base becomes more, not less, important as defense budgets decline.

Using the defense technology base as a strategic reserve will entail some changes in how the U.S. Department of Defense (DoD) views the role of the research and development (R&D) it supports. Too often, R&D programs that do not lead to fielded hardware are viewed as failures, and industry has few incentives to explore systems that are "going nowhere" in terms of production contracts. In the future, it should be normal practice for DoD to support exploration of weapon concepts—up to and including the early stages of development and prototype testing—that have no immediate prospect of deployment. The technology base will thus become not just the first stage of the acquisition process, but a forum for analysis and exploration of U.S. options under each of many future political scenarios, a notice to potential enemies of America's latent strength, and a mobilization base if large U.S. forces need to be reconstituted quickly.

When asked to identify the threat to which U.S. military security should now be directed, President Bush answered, "Unpredictability, uncertainty, and instability." Technology is an important insurance policy against an uncertain strategic future. It will help to preserve future options to meet a possible renewal of the Warsaw Pact threat, as well as the varied and changing but pressing demands of regional conflicts, proliferation of military technology to unstable nations, terrorism, and drugs. Preserving, and indeed broadening, the defense technology base in the face of a reduction in overall defense spending is an example of the "new thinking" required by the dramatic turn in world events.

## GLOBAL CHANGES IN TECHNOLOGY

A less sudden but comparably profound change has taken place in the global technology base. Over the past several decades, American private industry has been increasing its expenditures on research and development faster than has the federal government, and in particular faster than has the Defense Department. R&D spending by U.S. industry has quadrupled since 1960 in real terms, while federal R&D spending only doubled. Thus in 1960, DoD accounted for half of all U.S. R&D spending, but by 1990 DoD's fraction had shrunk to one-third. This secular decline occurred despite the defense buildup of the late 1970s and 1980s.

During this same period, R&D investments by America's Western trading partners and commercial competitors—especially Japan and Germany—have also grown rapidly as these nations have rebuilt their war-torn economies and regained their former places as major economic powers. The impact of the rapid relative growth of both domestic and international

nondefense R&D on the importance of DoD to the global technology base is dramatic. Thirty years ago, the Defense Department funded fully one-third of all the R&D performed in the Western industrialized world; today it funds one-sixth. In some high-technology sectors, the diminution of the defense role is even more striking. DoD was a major supporter and purchaser of microelectronics technology in 1960. Today, with sophisticated integrated circuits in automobiles and children's toys as well as missile guidance systems, DoD is a relatively minor player in this fast-moving technology.

Another concomitant of the sharp increase in foreign R&D spending has been the erosion of the across-the-board dominance in technology enjoyed by American commercial firms in the postwar period. Today America's position is best described as one of first among peers. That this position is the predictable result of a wise and deliberate American policy to encourage the economic recovery of its wartime enemies does not take away from the fact that America's trading partners have also become its technology competitors. To hold its own as first among peers, American high-technology commercial industry needs to excel in many fields, even if it cannot excel in all.

These changes in the global technology base have two implications for U.S. defense technology policy. First, DoD needs to draw upon the much larger commercial technology base for technologies that are not unique to defense. Second, the nation's economy as a whole needs to benefit from DoD's still-large expenditures on technology. These two objectives are closely linked, and many of the same policies would contribute to both.

For technologies of broad use to society as well as defense (for example, information technologies), the message is clear: Defense systems will incorporate newer and better technology if they use technology spawned in the commercial sector. But DoD has the bureaucratic instincts and habits of a technology leader that develops all the technology it needs—instincts and habits formed in earlier decades of technological dominance. To be sure, in fields where commercial and military needs are technically different, DoD can and must rely on its own R&D rather than on the commercial sector's. But elsewhere, the barriers to technology sharing between the commercial and defense sectors are purely nontechnical. These barriers include burdensome government contracting and accounting procedures, military security and proprietary restrictions, and unique military specifications. These barriers must be lowered if DoD is to have access to the latest commercial technology for its weapons.

Though defense R&D expenditures have declined in relative importance over the past 30 years, they remain very large. DoD is thus still a major potential source of new technology for the commercial sector, and the defense contribution to U.S. R&D spending—fully one-third of the total—is essential to America's position in world technology. With the defense con-

tribution included, U.S. R&D spending is about equal to the combined spending of the country's six major competitors: Japan, Germany, France, the United Kingdom, Italy, and Canada. It also amounts to almost as large a fraction of gross national product (GNP) in the U.S. as it does in Japan and Germany. But if defense R&D spending is omitted from these measures, the U.S. position appears very different. Japan and Germany surpassed the United States in the fraction of GNP spent on nondefense R&D two decades ago, and have increased their lead since. These comparative measures, albeit crude, indicate that it is important for defense R&D to make a contribution to overall national well-being.

So-called "spinoffs" from defense to commerce are fewer and less important today than in previous decades. But in some fields the magnitude of defense's investments, and its sometime willingness to seek high potential payoff in return for high financial risk in a way that the private sector cannot or will not, can make a contribution that benefits the whole nation. Fostering such technology transfer from defense to the rest of the economy will require removal of the same barriers that prevent transfer of technology in the other direction.

At the very least, the Defense Department ought to do its share to renew the pool of new knowledge and trained scientists and engineers upon which it draws for the accomplishment of its mission. Here the changes over the past few decades are disappointing. DoD support of basic research has actually declined by almost 40 percent in real terms since the 1960s. DoD is the federal government's largest purchaser of technology. Its expenditures on engineering development of specific weapons, funded through the so-called 6.3B, 6.4, 6.5, and 6.6 accounts of its research, development, test, and evaluation (RDT&E) budget, are almost as large as the total engineering development expenditures of the entire commercial economy. Yet DoD funds less than one-tenth of the nation's basic research. DoD expenditures for basic research (6.1), applied research (6.2), and large-scale experimentation (6.3A) have not shared in the defense buildup of the later Carter and Reagan years. In a decade when overall defense RDT&E doubled in real terms, basic and applied research enjoyed essentially no growth. DoD is the only major federal R&D sponsor whose basic research budget failed to grow in the 1980s. The Defense Department's 6.3A spending did grow dramatically, but most of this growth was for the technologically broad, but still application-specific, Strategic Defense Initiative.

In the U.S. system of support for science and technology, individual "mission agencies" like DoD are supposed to contribute to the national technology base as well as to supply their own technology needs. The United States has no central ministry of science and technology. DoD's "deposits" into the national technology base are not commensurate with its "withdrawals"

in terms of advanced weapons technology. In an era of heightened international competition in high technology, this imbalance has implications that go beyond national security.

## PROBLEMS IN DEFENSE ACQUISITION

Another factor requiring "new thinking" for American defense technology is a widely perceived crisis in defense acquisition. Defense systems cost too much, take too long to develop and produce, and nonetheless frequently fail to perform to expectation. By no means can these problems properly be attributed solely to poor management of technology. Though weapons and military information systems frequently incorporate new and demanding technology, some problems arise out of the sheer complexity and novelty of the systems in which the technology is applied. And high cost, long schedules, and poor performance have many nontechnical causes, ranging from ponderous procurement regulations to financial ill health in the contractor base, and from unstable political support for individual programs to perverse incentives in government contracting. A number of efforts have been and continue to be made to reform defense acquisition, most notably in the Packard Commission and the recent Defense Management Review. These reforms acknowledge that the acquisition problem is broadly based. Many of the most significant reforms recommended through the Packard Commission, particularly those that deal with the selection of weapon systems, are beyond the scope of this report. Nevertheless, since DoD systems rely heavily on advanced technology, departmental organization and decision making for science and technology are important factors in ensuring that the nation gets good value from its defense expenditures.

Efficient acquisition of high-technology defense systems requires a vigorous defense technology base that is strongly tied into the large and fast-moving commercial technology base. This technology base, which is responsible for the "upstream" processes of research and exploration of new technology, must be firmly linked in turn to the "downstream" processes of engineering development, manufacturing, and maintenance. Finally, defense program management, and the defense industrial base, need to be stable and flexible enough to take the long-term view and to accept the risk inherent in applying new technology. Above all perhaps, the Secretary of Defense needs objective and technically competent advice upon which to base decisions about which projects are feasible and affordable in the first place. This is by no means the only factor in the decision to produce a new weapon system, but it is a critical one. Acquisition reform and successful technology management are mutually dependent.

2

# PROVIDING HIGH-LEVEL ATTENTION AND OVERSIGHT OF SCIENCE AND TECHNOLOGY ISSUES

## IN THE WHITE HOUSE

The President has a direct, day-to-day involvement in problems of national security, with more decisions receiving his personal attention in this field than in any other area of national policy. Science and technology play an important role both in causing and in solving national security problems. Presidential decision making would therefore benefit from a White House advisory mechanism combining expertise in national security policy with expertise in science and technology. Past experience shows that presidential advisers need to be persons of stature and accomplishment in science and technology who can tap relevant expertise in the wider technical community, persons of breadth who are acquainted with national security affairs and with the workings of government, persons of independence who can serve the President free from parochial interests, and persons of discretion who could be trusted with access to the presidential decision-making process.

A national security science and technology advisory mechanism could provide several important services to the President:

- A cross-cutting, national-level perspective on the technology-related programs and policies of the Executive Branch departments involved in national security affairs: the Departments of Defense, State, and Energy; the Central Intelligence Agency in traditional security areas like nuclear weapons, space, arms control, and intelligence; and increasingly, the Departments of Commerce, Treasury, and Justice and the National Science Foundation, for such emerging security issues as proliferation of high-technology weapons, export controls, the defense technology base, "dependency" on foreign suppliers of key defense technologies, terrorism, and drugs
- Independent analyses of major programs and policies proposed to the President by cabinet departments (for example, the B-2 bomber, anti-submarine warfare technologies, security classification of scientific information, cleanup of the nuclear weapons complex, or reconnaissance satellites)
- Informal, *ad hoc*, discreet, quick-turnaround advice on technology-intensive security issues of immediate presidential concern

A presidential advisory mechanism fulfilling these needs could be provided with the existing White House structure, without creating any new organizations, through the joint action of the Assistant to the President for National Security Affairs (the security adviser) and the Assistant to the President for Science and Technology (the science adviser).

- **The Task Force recommends** that a national security science and technology advisory panel be convened under the combined auspices of the security adviser and the science adviser. Panel members would be appointed by the President, with the chairman and half the members nominated by the security adviser and half by the science adviser. Staff to the panel would be provided equally from the offices of the security and science advisers, with a staff director chosen by the security adviser. The panel's tasks would be selected by the President or by mutual agreement of the security and science advisers, and panel reports would be approved by both advisers before going to the President. An administrative structure for the national security science and technology panel might be found in association with the existing President's Council of Advisers on Science and Technology (PCAST).

An informal mechanism such as the panel proposed here could serve the vital need of supplying high-level, technically informed, independent, and discreet advice within the White House on the increasing number of national security matters containing a strong scientific or technological component. It would offer the national security adviser a mechanism for obtaining

technical advice independent of the parochial interests of the executive branch departments, yet from a body of advisers he shares in selecting and tasking, and thus trusts. And it would renew the successful involvement of presidential science advisers in national security affairs of a generation ago without distorting the current PCAST's primary—and appropriate—emphasis on nonsecurity science and technology issues.

## IN THE DEFENSE DEPARTMENT

No other cabinet department relies as heavily as the Department of Defense upon science and technology for the accomplishment of its mission, and no other department spends more money on research and development. The senior civilian leadership of the Defense Department is therefore usually reliant upon science and technology advice that is well informed but independent of military service and defense industry interests. This need is all the greater today, when changes in the world compel a reorientation of U.S. defenses to new missions, when uncertainty about the strategic future demands the protection of options such as technology provides, when declining defense budgets force hard choices among high-technology defense systems, and when the acquisition system's ability to tap technology, especially technology developed in the commercial world, is widely criticized.

The need for science advising in the Office of the Secretary of Defense is compelling, but there are signs that existing advisory mechanisms need improvement. The Defense Science Board (DSB) was established to provide the Secretary of Defense with disinterested, expert advice on science and technology. In recent years, the DSB has broadened its representation to include members expert in the management of defense industries as well as members expert in military operations, and this trend has been accentuated by the recent merger of the DSB and the Defense Manufacturing Board. These types of expertise are necessary to deal with questions the DSB has been (and should be) tasked to answer. But the perception of conflict of interest can affect the ability of the DSB to be the Defense Secretary's independent quality control on the department's science and technology analyses and programs.

A second concern is that the DSB has become a forum for airing broad issues regarding the relationship between the government and the defense industry, trend in conflict with the DSB's role of independent science and technology adviser. As recommended below, such DoD–industry consultations should be encouraged, but they should take place in a separate formally constituted body, not in the DSB.

Third, it is important that the DSB, as the senior advisory body on matters of science and technology in the Defense Department, pursue studies of direct importance to the Secretary, report directly to him, and have enough contact with the Secretary to anticipate his needs. Otherwise, there is a danger that the DSB will fail to contribute to important issues of broad national security concern and will focus only on a narrower (though important) menu of purely scientific and technological issues falling within the purview of the Undersecretary of Defense for Acquisition or the Director of Defense Research and Engineering. The DSB also needs to maintain strong ties to the Joint Chiefs of Staff and to the Undersecretary for Policy.

■ **The Task Force recommends** that the Secretary of Defense take the following steps to strengthen the Defense Science Board as an independent source of advice on science and technology in the DoD:

■ As new members are selected for the DSB, emphasize the selection of younger members, particularly those with backgrounds independent of the defense industry (academic, nondefense industrial, and think-tank scientists and technologists).

■ Broaden the scope of the existing Defense Policy Advisory Committee on Trade (DPACT) to make it a forum for cooperative discussion between senior Defense Department officials and defense industry executives regarding issues of mutual concern, such as the health of the defense industrial base, contracting, auditing, and oversight procedures, international cooperation, standards of ethical conduct, and other nontechnical issues whose resolution is essential to the efficient long-term performance of DoD's mission.

■ Continue to have the DSB report directly to the Secretary of Defense.

■ Encourage the DSB, through its chairman, to propose study topics for approval by the Secretary.

■ Continue to encourage tasking of the DSB by the chairman of the Joint Chiefs of Staff, and by the Undersecretary of Defense for Policy.

■ Direct the executive secretaries of the DSB, the Naval Research Advisory Committee, the Army Science Board, and the Air Force Scientific Advisory Board to meet periodically to share the plans and studies of their respective boards and, where appropriate, to recommend further coordination or joint studies to their respective board chairmen.

■ Direct the Director of Defense Research and Engineering to provide stable core funding to the JASON scientific study group to ensure continued creative innovation and peer review of cutting-edge DoD technical programs by this part-time body of academic scientists.

# 3
# STRENGTHENING THE DEFENSE TECHNOLOGY BASE

The political changes in the Soviet Union and Eastern Europe, and the reductions in defense expenditures certain to follow in their wake, call for more, not less, emphasis on the defense technology base within the defense budget. Heightened attention to defense technology is required, as explained in Chapter 1, to provide a "reserve" capability in defense technology to meet the uncertain needs of U.S. security in the future.

But the natural tendencies of the services and Congress will be to cut defense technology-base programs. The defense technology base is created and maintained in industrial laboratories, universities, and government laboratories. It is part of, and in important respects is indistinguishable from, the national technology base. Despite the continuing—or, as noted above, actually increasing—dependence of national security on technology, the defense technology base has been steadily losing budgetary support. The annual budget for the defense technology base (defined in budget terms as the sum of the 6.1 and 6.2 accounts) was at its high point in the 1960s. Measured

in real dollars, it dropped to a mere 50 percent of that level in the general budget decline after the Vietnam War, increased to about 60 percent of that level during the Carter Administration, and then remained at 60 percent during the 1980s. Thus the defense technology base did not participate in the dramatic increase in defense spending that occurred during the Reagan administration. Today just over 1 percent of the defense budget and less than 10 percent of defense R&D spending is for the technology base, which is the "R" in R&D. Technology base support should certainly not participate in the decline in overall defense spending now under way.

Not only considerations of national security recommend increased support for the defense technology base. DoD is, as detailed in Chapter 1, a major consumer of science and technology. DoD is also a major consumer of science and engineering personnel: One-third of all American scientists and engineers (outside the biomedical fields) work on defense projects. DoD therefore ought to, and in the past did, resupply that national technology base from which it draws. America's overall technology base supports other national needs, including economic competitiveness. Current DoD "deposits" into the national pool of basic and applied research are out of line with its "withdrawals" in terms of high technology.

The defense technology base requires strengthened management in addition to adequate funding. In 1986 the post of Undersecretary of Defense for Research and Engineering was eliminated, and the post of Undersecretary of Defense for Acquisition was created. At the same time, the post of Director of Defense Research and Engineering was recreated and made subordinate to the Undersecretary of Defense for Acquisition. These changes reflected a need to strengthen the "back end" of the weapons acquisition process, including engineering development, manufacturing, contracting, and industrial-base management. But this emphasis on the back end, while necessary and desirable, has weakened the "front end" of the process, consisting of research technology generation, and tentative exploration of military applications.

An important portion of the defense technology base, namely the government-supported laboratories of the Department of Defense, needs overhaul. The 68 laboratories and technology centers run by the armed services perform or manage $10 billion worth of front-end technical activities. These laboratories are uneven in quality and poorly coordinated with one another, with the future technology needs of the DoD, and with the opportunities afforded by emerging technologies. Some are too small to have a critical mass of productive activity in any field; some were created to advance fields that are now obsolete; some are neglected by their service patrons. All suffer from unforgiving civil service personnel policies and bureaucratic red tape.

Finally, the manner in which technology-base activities are contracted by DoD needs attention. The defense acquisition reforms called for by the Packard Commission report could have a major beneficial effect on defense technology. The reforms call for program managers to take a long-term view of defense programs, a trend that can only help technology. The reforms also call for the DoD to accept the long-term health of the defense industry as in part its responsibility, in turn encouraging the defense industry to invest in long-term technology. Additionally, the reforms seek to break down the barriers between military and commercial production (created by unique military specifications, contracting and bookkeeping practices, and inspections and oversight), ultimately allowing there to be true dual-use industries producing—and innovating—for both defense and nondefense markets. Finally, the reforms encourage engineering tradeoffs between cost and performance, and these tradeoffs can push technology forward even more than the open-ended pursuit of higher performance.

The Packard Commission also pointed to the need for a separate effort to reform regulation and contracting within the technology base. Acquiring technical systems and acquiring technology are not the same thing. Defense technologists labor under a burden of regulations that emphasize avoidance of risk. These regulations have grown by steady accretion, and a zero-based review is needed. The review should begin from the point of view that R&D contracting and regulation need to be treated differently from other acquisition activities, and in particular that R&D contracting should be based on a competition in ideas rather than cost.

■ **The Task Force recommends** the following steps to strengthen the defense technology base:

■ Reapportion the Defense Department's research, development, test, and evaluation budget to allow for modest but sustained increases (after inflation) in the 6.1 and 6.2 categories (basic and applied research) at the expense of the 6.4, 6.5, and 6.6 categories (covering detailed engineering of weapons selected for production), even in the face of declining overall RDT&E budgets.

■ Assign to the Director of Defense Research and Engineering the management and budget defense of the 6.1 and 6.2 activities as a consolidated program, with execution of the approved program and selection and management of projects remaining with the military services.

■ Establish a commission reporting to the Secretary of Defense, and patterned on the "base-closing" commission, to review all DoD laboratories and to recommend for each one: closing it, consolidating it with another

government laboratory (DoD or Department of Energy), converting it to contractor operation, or expanding its functions and budget.

■ Establish an entirely different set of procurement procedures for 6.1 and 6.2 contracts from those used for development and procurement contracts. These streamlined procedures, described in the Packard Commission report, would dramatically reduce both cost and schedule and would focus technology-base funding on a competition in ideas, not in cost.

# 4
# STIMULATING THE DIFFUSION OF HIGH-LEVERAGE TECHNOLOGIES FROM THE LABORATORY TO THE FIELD

The armed services, like industrial companies, have difficulty transferring their best technologies from the laboratory to new products in a timely way. The DoD's 6.3A program is intended to facilitate such transfer by funding the building and testing of "breadboard" prototypes that, while inexpensive and quickly assembled, still allow for demonstrating the feasibility of a technology in the military application foreseen for it. The Packard Commission recommended a greatly increased emphasis on prototyping. Prototyping not only speeds the introduction of new technology into fielded defense systems; even more importantly, it allows decisions regarding which weapons should enter full-scale development in the first place to be made on the basis of better information about their likely cost, performance, and development schedule.

Prototyping programs are typically conceived, funded, and managed by the military service concerned. This procedure is usually appropriate because it keeps the ultimate users of the technology closely involved in its

development. In cases involving especially high risk (and correspondingly high potential payoff), the Defense Advanced Research Projects Agency (DARPA) has sponsored the prototyping effort before "handing it off" to the service. Such was the case with the Stealth program. The Secretary of Defense has also given (or threatened to give) DARPA the lead in cases where the cognizant service was reluctant, or where the program was destined for multiservice or joint use.

The technology-base program is critically important as a self-renewing source of ideas that might lead to major improvements in defense capability. But until these ideas are modeled and tested, their potential is unproven. Therefore, strengthening the 6.3A program is as important as strengthening the 6.1 and 6.2 programs to the objective of creating a defense technology "reserve" for the uncertain strategic future.

■ **The Task Force recommends** the following steps to improve the diffusion of technology from the laboratory to the field in the Defense Department:

■ Maintain the current level of 6.3A funding, even in the face of a declining overall defense RDT&E budget, at the expense of the 6.3B, 6.4, 6.5, and 6.6 accounts.

■ Require system prototyping and testing on major programs before making the decision to enter full-scale development.

■ Conduct a deliberate and carefully selected program of modeling and testing on promising technical concepts to build up a "reserve" of ideas and to maintain skilled engineering teams that could be mobilized quickly (that is, over a few rather than many years) in the event the United States is confronted with a resumption of the cold war. The reserve would not consist of complete "on-the-shelf" engineering designs that would quickly grow obsolete, but instead would consist of a dynamic exploratory program that would pursue a wide range of technical possibilities and, importantly, that would keep together groups of scientists and engineers with knowledge of important military problems. This reserve activity should be conducted within the 6.3A program. It should include both entirely new concepts to respond to entirely new military contingencies; and evolutionary improvements to existing defense systems that DoD will not be able to afford to replace since such improvements require just as much high technology and quality engineering as new systems. The technology reserve should also give attention to the manufacturing processes that would be required to produce systems cheaply and quickly.

■ Employ the same streamlined procurement procedures for 6.3A contracts as for 6.1 and 6.2 contracts.

- Maintain the current role of DARPA in prototyping, but not to the exclusion of prototyping by the services or to the exclusion of DARPA's role in research and technology exploration.

5

# STIMULATING THE DIFFUSION OF DUAL-USE TECHNOLOGIES INTO INDUSTRY

Dual-use technologies are technologies that are important to defense but that also have important applications to commercial products. Prominent examples of dual-use technologies are supercomputers, semiconductors, large-scale software design, computer networking, and transport helicopters. In many of these fields, the Defense Department has sponsored innovative technologies that have diffused, in time, to the commercial sector. Moreover, technology diffusion has been a specific objective of DARPA on a few selected programs. The most notable of these programs are HDTV (high-definition television), which seeks to develop flat panel displays for military command systems that could also be a component in the next generation of television sets, and SEMATECH, which supports the development of advanced semiconductor processing equipment. These programs have been controversial since they have been interpreted by some as examples of the government formulating industrial policy. The involvement of DARPA has

been even more controversial since it is argued that defense funds should not be used for commercial purposes.

We believe that this controversy is based on a misunderstanding—by both critics and advocates—of the scope and objectives of technology diffusion programs. While the Defense Department cannot, and should not, be responsible for the nation's industrial competitiveness, it should facilitate the use of the technologies it generates for the benefit of the entire nation. Accomplishing this goal will require making diffusion an explicit objective of selected defense programs, and procedures and incentives to effect technology transfer from defense to commerce in a timely and efficient manner.

■ **The Task Force recommends** the following actions to stimulate the diffusion of dual-use technologies into industry:

■ The Administration and the Congress should broaden the charter of the Defense Advanced Research Projects Agency to include specific responsibility for facilitating the transfer of selected defense technologies whenever they have important commercial applications. This does not mean that DARPA would be the only, or even the most important, federal agency for stimulating commercial technology. DARPA's role would be limited to dual-use technology where the defense application was truly critical to defense.

■ The Secretary of Defense should continue to be responsible for DARPA, but the Secretary of Commerce should be encouraged to provide additional funding to accelerate the transfer process on technologies of special interest to the commercial sector.

■ DARPA should continue to be the first choice for sponsoring a new technology program whenever that technology is critical to defense, and whenever it is large scale and long term (and thus less likely to be funded by industry).

■ Contracting for dual-use technology programs should employ the same streamlined procedures as recommended for technology-base programs.

■ The Defense Department's Independent Research and Development (IR&D) program should be used to encourage companies to align their defense and commercial technology efforts to the mutual benefit of both. IR&D reimbursements, like 6.1, 6.2, and 6.3A contract funding, should therefore not share in the anticipated decline in overall defense RDT&E and procurement funding, and IR&D reimbursements should not be supplanted by bid and proposal reimbursements.

■ The Assistant to the President for Science and Technology should review and recommend new modalities for both the transfer of defense tech-

nology to commercial applications and for the timely use of commercially developed technology in defense systems. The overview should cover such issues as contracting and auditing procedures that result in the segregation of defense and commercial efforts within industry, and classification and data rights regulations that discourage dual use. This overview would be facilitated by establishing a White House-level technology transfer review committee chaired by the science adviser and including among its members representatives of the Departments of Defense, Commerce, Energy, and possibly other agencies.

# 6
# INCREASING DEFENSE USE OF COMMERCIAL TECHNOLOGY

Research and development spending in private commercial industry and in other Western nations has been growing faster than defense R&D spending for decades, as described in Chapter 1. In many fields of advanced technology, the Defense Department is a bit player, both as a supporter of technology generation and as a customer for new technology. The resulting growing dependency of defense upon technology it does not develop itself can be turned to advantage if the DoD can learn to draw upon the commercial world for those technologies that are not uniquely military.

Today, only a small percentage of components purchased by defense procurement offices are commercial "off-the-shelf" products. Both the Packard Commission and the Defense Science Board have noted that, as a result, the components in defense systems often embody old technology and cost more than their commercial counterparts. In semiconductor purchases, for example, defense buyers pay as much as 10 times more than commercial buyers for equivalent, and in some cases physically identical, parts. The failure

to use commercial components when their use has such obvious advantages stems from an overly rigid insistence on military specifications ("milspecs") and from procurement regulations that discourage commercial suppliers from seeking defense markets. Correcting this problem would not only yield immediate cost savings in defense systems, but would strengthen the U.S. industrial base over the long term.

Perhaps most importantly, to the extent that our defense systems embody commercial components, our commercial industry would become an automatic "reserve force" that could rapidly increase defense production in the event of national emergency. Moreover, employing widely used commercial components facilitates the continuing low-cost purchase of spare parts and the upgrading of systems by incorporating later-model, but compatible, components throughout the lifetime of a defense system (which is frequently measured in decades).

There are, however, formidable barriers to defense purchasing officers attempting to increase their percentage of commercial component buys. The barriers are military specifications, security regulations, and procurement regulations, all of which were established for good reasons, but whose application in this area has become counterproductive.

■ **The Task Force recommends** the following actions to achieve the benefits that would result from increased commercial buys by defense:

■ The Defense Department should replace milspec standards with dual military–industrial standards, which will be guided primarily by industrial needs whenever commercial applications dominate the market. Milspec standards will be used on an exception basis only, for example in systems that must operate in a nuclear environment. The National Institute of Standards and Technology should take the lead in establishing standards that would be functionally applicable both to industrial and to defense applications.

■ The Defense Department should adopt the Uniform Commercial Code for the procurement of commercial products. This will require some modification to laws as well as to regulations. As long as DoD insists on having its own rules for buying, defense suppliers will be found in enclaves dedicated to meeting DoD rules at higher cost to the taxpayer. In particular, to break out of that enclave, the Defense Department must be prepared to waive data rights in dealing with commercial suppliers.

■ The Defense Department should establish procurement regulations that give precedence to commercial products (including software) whenever they are available. This precedence should apply not only to components, but to larger equipment and to entire systems (for example, trucks)

wherever possible. (DoD already has established a program to stimulate the purchase of so-called nondevelopmental items—i.e., items not developed specifically for defense—but the barriers described above have discouraged the program's full execution.)

■ ■ ■

Science and technology can continue to serve national security in the years ahead only if creative adaptation in government organization and decision making keeps pace with changes in world politics, in the world economic system, and in technology itself. Creative adaptation will require the kind of "new thinking" described in this Task Force report.

# 7
# A RADICAL REFORM OF THE DEFENSE ACQUISITION SYSTEM*

## EXECUTIVE SUMMARY

**The Carnegie Commission on Science, Technology, and Government recommends that the Secretary of Defense undertake, with high priority, a radical reform of the defense acquisition system.**

The many studies on defense acquisition agree that the system is bloated and inefficient and have made detailed recommendations on how to improve it, but previous attempts have failed because they tried to build on a fundamentally flawed foundation.

What is required is a complete break with the present system, and the creation of a new system based on the best of the acquisition processes used by large corporations when they undertake major development projects, such as a new generation of commercial transport aircraft. Such a new

* This statement was released in December 1992.

system would allow the integration over time of the defense industrial base with the commercial industrial base–an integration that will bring not only major benefits to our national security but also important improvements in the competitive posture of many of our large corporations. It would also signal an important philosophical shift by the new administration tied to the broader goals of strengthening the national economy and reducing the size of government.

## THE PROBLEM

Previous studies by the Defense Science Board, the Grace Commission, the Packard Commission, the Congress, and a number of universities have documented the inefficiencies of the present acquisition process. Congress and the Defense Department, in an effort to eliminate "waste, fraud and abuse," have created a myriad of laws and regulations, which in turn have led to thousands of documents describing in elaborate detail how every weapon system—and every belt buckle—should be developed and procured. The Defense Department has established an army of several hundred thousand acquisition personnel to oversee the process spelled out in those documents. Industry in turn has added hundreds of thousands of people to their staffs to cope with the government overseers. All of this overhead structure is paid for, one way or the other, by the taxpayers.

It is impossible to estimate precisely the full cost of regulation in the present acquisition system; however, a surrogate for regulation cost is the cost of the personnel in DoD and the defense industry dedicated to management and control. That cost in FY 1991 is estimated to be over $50 billion, or about 40 percent of the acquisition budget that year. (This compares with management and control burdens in commercial practice that range from 5 percent to 15 percent.) But high overhead costs are not the only problem with the present acquisition process. It also imposes severe schedule penalties—the acquisition schedules that result from this process are two to three times as long as commercial schedules for comparable systems. (The B-2 acquisition schedule, for example, was about three times that of the Boeing 767.) And there are serious performance penalties as well—nearly all of our military systems embody technology that is a generation or two behind their commercial counterparts.

These well-documented inefficiencies, which have plagued us for many years, are compounded by three problems arising from the significant downturn in defense spending now under way and likely to continue for a number of years:

■ First, as defense spending decreases, the overhead cost of regulation (management and control), which is already about 40 percent of the acquisition budget, would consume as much as 70 percent of that budget if the present overhead control structure were left in place. Both the DoD and defense contractors will need to downsize their management and control staffs at least proportionally to the decreased size of the defense budget. But simple downsizing is not enough: we should take this opportunity to restructure our defense acquisition processes around modern management techniques. During the last few years, our most successful commercial industries have all restructured their manufacturing processes and support teams—based on Total Quality Management concepts, statistical quality control, and just-in-time inventory—in order to achieve increased competitiveness in world markets. Defense should do no less!

■ Second, while many defense companies have tried to convert to the production of commercial products in response to changes in defense spending, they have been largely unsuccessful because of the overhead burden and inefficient processes that are the legacy of the present defense acquisition process. Defense engineers and managers are among the best in the world, and they could readily develop the capability to compete in commercial markets if they became trained in commercial practices.

■ Finally, with the downsizing now under way, our defense industrial base will provide too small a base if our country ever needs to reconstitute a major defense production capability. If that contingency arose, we would have to build on the then-existing commercial/industrial base just as we did at the beginning of World War II. However, our defense equipment and acquisition process is now encumbered by a bewildering array of defense-peculiar standards and processes that have proliferated since World War II and that are incompatible with the processes and standards used by our commercial industry. (Indeed, large corporations that have both a defense and a commercial business currently structure them in separate organizations, usually physically separated, so that the defense processes will not "contaminate" their commercial business.)

## THE RECOMMENDED SOLUTION

**The reform of the defense acquisition system must have as its principal thrust the integration of the country's defense industry and commercial industry to create a single industrial base.**

Given the expected size of the defense industry in the 1990s, the increasing importance of commercial technologies to defense, and the need of our com-

mercial industry to get the full benefits of defense technology advances, we can no longer afford the luxury of maintaining two distinct industrial bases.

Achieving this integration requires making a complete break with the present system. The needed reform consists of replacing the current acquisition system with an existing system that needs no new invention and that is used by most companies every day: common commercial buying practices. *The critical ingredient of adaptation to commercial practice is conversion from a regulation-based system to a market-based system.* Numerous studies have made it clear that the problems with the defense acquisition system are rooted deeply in the regulation-based system of procurement, with its insidious system of "allowable overhead." Such a system is clearly vulnerable to abuse by contractors who are careless about passing unallowable costs on to the government. The government responds to this vulnerability of the public purse by dispatching thousands of inspectors and auditors to oversee defense contractors. These government contractors in turn are matched—on a person-by-person basis at least—by counterpart accountants and auditors employed by industry. Eliminating this fundamental vulnerability to abuse and making drastic reductions in the personnel superstructure that goes with it would reduce defense expenditures by several tens of billions of dollars each year. By way of illustration, if we had been able to reduce the management and control burden in last year's acquisition budget to 20 percent (still more than is typical in commercial practice), $25 billion would have been saved that year.

The Task Force believes that this is a practical and achievable reform and that a transition from the old system to a new one can be accomplished smoothly. The strategy is to create simply worded legislation and regulation changes that will enable and encourage the Secretary of Defense to apply best commercial practices and gradually withdraw from the present system. To change all of the current contracts, organizations, and procedures of the department immediately would, of course, be impractical. However, it is realistic to begin immediately by permitting commercial practices to be used now where practical. Both the current system and the new price-based, commercial-practice system would operate in parallel for several years as the Department of Defense gradually moves programs, contracts, organizations and procedures into this new mode. It should be possible to move most of the procurement activity to the new process within the first four-year term of the administration.

**This move to a new market-based system must not and need not dilute the government's obligation to assure that it obtains fair value for the taxpayer's money, with equitable treatment for all contractors.** The Commission is aware that government procurement will always operate under different constraints

from private sector procurement. But under the new system, many tools will continue to be available to the government to meet its unique needs and constraints for spending public monies, which will be at least as effective as the current practice of determining in detail the cost of a product in order to decide what to pay for it. Competition will continue to be available in most circumstances–it will simply take place on the basis of value rather than cost. Commercial practices contain sensible ways of establishing a fair price. Very importantly, the government has an obligation to understand the value of what it wishes to acquire. Today's archaic and destructive "requirements process" results in neither a real determination of what is required nor any attempt to establish value, and this process should be changed in any event. Managing risk in high-technology programs is now well understood in commercial practice, and there are many mechanisms available to achieve that effectively in the new system. We can and must use these common commercial techniques to the public's advantage.

## IMPLEMENTATION ISSUES

Implementing this recommendation will be very difficult because the present defense acquisition system is deeply ingrained in practice and law. Long-established ways of doing business would have to be changed; many institutional oxen would be gored. Thus, to effect such a fundamental change will require a major commitment of political capital by the President and the Secretary of Defense to gain the support of the services and the key committees of Congress. Service support would be facilitated if the Secretary of Defense makes clear from the beginning that the basic role of the services in acquisition would be maintained: in other words, this is not a move to centralize defense acquisition and move it away from the users. Congressional support would be facilitated if the President organizes a commission, patterned after the "base-closing" commission, to recommend the necessary changes in acquisition law and agency mandates, including phasing down agencies or subagencies where necessary.

■ ■ ■

This initiative would send an important signal that the new administration is serious about national security as well as economic well-being; indeed, it emphasizes that they are closely interrelated. Successfully implemented, it will result in huge gains in efficiency and effectiveness, and will allow us to maintain a strong defense capability while we are making major re-

ductions in defense spending. The effort required would be substantial, but the prize is large—in reduced expenditures, in increased national security, and in the increased strength of our national industrial base.

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* Most biographies are current as of August 1990, when the first edition of this report was published. Biographies of Richard F. Celeste, Robert J. Hermann, Rodney W. Nichols, and R. James Woolsey, who joined the Task Force in its more recent deliberations, are current as of April 1993.

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